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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London 1909.)

Among other articles this number contains :—

Illuminating Engineering Practice
(a Review of the Course of Lectures delivered at the University of Pennsylvania U.S.A.).

Notes on Automobile Headlights and Flood-lighting Projectors.

The Organisation of Engineering Training.

Other matters dealt with include :—

RULED GLASSES FOR PHOTOMETRY—LIABILITY FOR FAILURE TO LIGHT STREET LAMPS—GLASS RESEARCH—MAINTENANCE OF GAS LAMPS, etc.

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EDITORIAL.

The Organisation of Engineering Training.

It will be recalled that on September 27th a preliminary account of the aims of those associated with the movement for the improvement of engineering training was given by Mr. A. E. Berriman and Mr. A. P. M. Fleming, before a gathering of representatives of the Press at the Institute of Journalists on September 27th.*

At the Institution of Civil Engineers on October 25th an important conference on the subject took place, and an account of the proceedings appears in our present number (pp. 265, 266). The meeting was attended by a number of distinguished delegates representing the educational and engineering aspects of the subject, as well as officials of various Government Departments concerned.

* *Illum. Eng.*, September, 1917, p. 244.

There was practical unanimity regarding the need for some better system of co-ordinating engineering training. The methods pursued by some of the leading engineering firms in the country are recognised to be adequate; but in other cases there is still a tendency to disregard the employer's duty of promoting the welfare of apprentices and ensuring the continuity of education such as would assist them to become intelligent and useful members of the engineering industry, and not merely machines. Again the education provided at our leading Colleges and Engineering Institutions is rightly regarded as second to none. The drawback has been that insufficient use of such institutions has been made, that the education is not developed on a large enough scale, and that the relations between them and the engineering works are not, in general, sufficiently intimate. As an instance Professor Dalby mentioned that when he visited Charlottenburg ten years ago he found about 10,000 students at work, whereas it would be difficult to find 900 students of similar class in this country.

In any steps that are taken to improve the engineering training of the country the utilisation in the fullest manner of the existing educational facilities will no doubt be borne in mind. For example, as suggested by the Rt. Hon. Arthur Dyke Acland, some of the bursaries and scholarships which are to be created by the Government might well be allotted to gifted youths entering the engineering industry.

Yet another weakness in the existing training facilities is that parents are often at a loss to know where to turn for information as to the best method of entering the engineering profession, and on the prospects of a youth with any particular firm. In some instances large premiums have been paid and the results, after several years' apprenticeship, have been very disappointing. In other cases, too, parents have found that after paying for special technical education for their sons, their subsequent prospects are no better, and even worse than if they had entered the works immediately after leaving school. This anomaly needs to be corrected by making technical education an essential part of works training, either by organising classes during working hours on the premises, or by allowing pupils time off from working hours to take courses at the local technical institution.

It was pointed out in the discussion that various universities and educational institutions have appointments boards associated with them, and it would be an advantage if these could be related to the central organisation for the better co-ordination which the promoters of this movement have in view.

All such matters are now to receive consideration at the hands of the Committee, representative of leading engineering institutions, educational associations and universities and technical colleges of university rank, which it was resolved to appoint at the meeting on October 25th. We feel sure that good must come of this close association of educational and engineering interests and the representative character of the committee should ensure the problem being dealt with in a wide and authoritative manner. We would like to add, however, that the success of any scheme evolved for the co-ordination of engineering training depends primarily on the education of public opinion. We therefore welcome the arrangements made by the organisers to maintain contact with the scientific and technical Press, in order that the ground may be prepared through their influence for future action.

Automobile Headlights.

One highly interesting development since the outbreak of war is the use of concentrated filament lamps, in conjunction with suitable polished reflectors, to give what is equivalent to a searchlight-beam.

The use of small electric lamps in motor-car headlights was familiar to this country before the war. More recently the authorities have imposed special regulations regarding the power of such lights, so that conditions are essentially different in this country from those prevailing in the United States. In America, however, the problem of the proper design of motor-car headlights, from the standpoint of traffic, has been actively discussed of late. The Illuminating Engineering Society and the Association of Automobile Engineers have been in co-operation with a view to defining the conditions requisite to provide sufficient illumination of the road-surface without causing excessive glare to pedestrians and approaching vehicles. The problem is a highly complicated one. The various States have endeavoured to deal with the problem by legislation, in some cases limiting the candlepower of the beam, in others prescribing a minimum distance for which the beam must carry. In most cases some attempt is made to limit the beam below the horizontal so as to illuminate the road without dazzling unduly the eyes of approaching drivers. One difficulty, however, is that the beam-conditions which are best adapted to a dark road having relatively little traffic are distinctly different from those which should be adopted in a well-lighted but very busy street. It has been suggested that alternative lighting arrangements should be at the disposal of the driver so that he can apply either method, according to the nature of the traffic, as his judgment finds most suitable.

It is obvious that in very dark surroundings almost any form of head-light involves some degree of glare. There is general recognition that very powerful beams, which can easily be attained, are unduly glaring and in some cases the limit of 1,000 candlepower has been advocated. Yet, on a very dark road, this intensity may give rise to dazzle, even when the attempt is made to keep the rays below the horizontal. It is necessary, therefore, to aim at a compromise between the provision of sufficient road-illumination and the avoidance of glare. From the motorist's standpoint the distribution of light along the road is likewise important. A " spotty " effect, *i.e.*, a bright patch a short distance ahead of the car followed by complete obscurity, is highly inconvenient, and it is also desirable that some subdued light should be allowed to pass to the sides of the road if this can be done without glare.

The design and use of headlights has also been discussed in this country both before and since the war. It was dealt with in a paper before the Illuminating Engineering Society by Dr. Hickman in 1911, at the International Roads Congress in 1913, and has recently received attention from the Royal Automobile Club, the National Physical Laboratory and other bodies.

The discussion on these various points that has been taking place in the United States is full of interest, and the experience gained should have useful applications in this country when normal traffic conditions are resumed after the war.

"Flood-lighting" Projectors.

The flood-lighting projector is a development intermediate between the automobile headlight and the arc-searchlight. In the former we have a relatively diffused beam, though naturally much more concentrated than is used in ordinary lighting units. In the arc-searchlight we have a very limited beam with a dispersion, in some cases, of 2° or even less.

The flood-lighting unit is a development which has made great progress in the United States since the outbreak of war. In this country it is little known as yet, except for certain specific purposes. These units employ a very concentrated filament lamp, with a suitable parabolic polished reflector. In the smaller units the dispersion is stated to be as little as 10° but provision is made to spread the beam, if desired, by putting the lamp slightly out of focus. In the larger units 16°—20° may be a more usual dispersion; by special diffusing cover-glasses this can be increased to 40°, when a wider beam is required.

The unit is thus equivalent to a searchlight with an incandescent filament of small dimensions as the source. From the data given in an article on the subject in the present issue (see pp. 259—263) it appears that with a 500-watt lamp a maximum candlepower exceeding 300,000 can be attained. In this case, however, it is clearly inadvisable to rate the unit in terms of maximum candlepower alone. The total flux of light in the beam is also of importance. According to the results quoted a projector using a 400-watt lamp, which gives 5,920 lumens, enables a beam to be secured with a total output of 2,940 lumens. The efficiency of the whole apparatus is thus about 40 per cent.

Such units might be expected to have important applications for work in which searchlights of moderate power are useful, and the ease with which it can be transported and switched on and off is an important consideration.

While flood-lighting units have been largely employed for spectacular lighting (*e.g.*, for the illumination of the National Capitol at Washington) before the war, they appear to be now proving useful for providing safety-lighting around arsenals, important factories, bridges, etc. With a relatively low consumption (estimated at 0·01—0·02 watt per square foot of area illuminated) adjacent areas can be flooded with light so that the presence of any unauthorised person can be at once detected by those on duty. This appears to be one more practical illustration of the truth of the saying that "Good lighting is the best policeman."

The special circumstances prevailing in the belligerent countries in Europe are not favourable to the general employment of these units at the present time. After the war, however, they may prove to have many important applications, and for spectacular lighting, for illuminating signs, façades, etc., they will often prove more economical than the customary methods of using a multitude of small exposed lamps. We recall that in the first volume of this journal we pointed out the desirability of such methods in referring to the lighting of the Franco-British Exhibition, and the matter has been frequently discussed in subsequent issues. It seems likely that concealed lighting methods will play a more important part in the exterior lighting of the future.

LEON GASTER.

SOME NOTES ON ELECTRIC HEADLIGHTS AND FLOOD-LIGHTING UNITS.

By An Engineering Correspondent.

The applications of concentrated filament electric lamps in suitable reflectors to produce a relatively narrow and powerful beam of light has been receiving much attention in the United States, and we have given several examples of notable "flood-lighting" installations in recent issues.

A cognate matter is the problem of the design of automobile headlights which has been the subject of study on the part of the American Illuminating Engineering Society and the Society of Automobile Engineers (U.S.A.). Some recent discussions on this subject were summarised in this journal a short time ago,* and we notice that several useful supplementary papers on the subject have since appeared

Automobile Headlights.

The problem resolves itself into a compromise between the requirements of illuminating the roadway ahead and eliminating, so far as possible, the inconvenience of glare. These two objects are, in a measure, inconsistent, and we can only make the best balance possible in the circumstances. On a dark road even a light of moderate brilliancy is apt to dazzle an approaching pedestrian. And though it may be so designed that the beam does not actually strike into his eyes, the mere fact of portions of the roadway and surrounding objects being relatively brightly lighted may prejudice his powers of vision. On the other hand the responsibility of avoiding accidents rests mainly with the more mobile and faster unit, *i.e.*, the motor-car, and it is chiefly important that drivers should see clearly any objects on the roadway, and that their headlights should not be mutually inconvenient.

It is evident that the ideal form of headlight will depend to some extent on the nature of the road. H. P. Gage, in a recent analysis of the problem,* divides roads into three categories: (a) Ordinary country roads, having relatively rough surfaces on which few other cars are encountered and the motorist has little to fear from glare through opposing headlights. Such roads are probably relatively rough and the driver must have enough light to look out for ruts and surface imperfections, but he has few moving objects to avoid.

From the motorist's standpoint this is a fairly easy problem; (b) macadamised city roads, or what are termed "State roads," where there are many vehicles and considerable difficulty is apt to be caused by glare. More attention should, therefore, be concentrated on avoidance of dazzle, and there is less necessity for a powerful headlight to illuminate the road. Finally we have (c), the city road, which receives ample artificial illumination, and where, therefore, the headlight has not much to do in the way of illuminating the road surface, and is of value chiefly as an indicator of the position of a vehicle.

The steps that have been taken to avoid glare have been chiefly in the direction of spreading the rays and bending them downwards. The effect of various types of beam is shown by the author by a series of photographs. It is recognised as prejudicial both to the driver and to approaching vehicles and pedestrians to have a headlight which concentrates the light in a very narrow region producing a spot of light a short distance ahead and then complete darkness. In these circumstances a driver cannot see the outlines of an approaching car until it is almost on him. A more recent refinement is the design of a type of headlight which excludes light from

* *Illum. Eng.*, July, 1917, p. 183.

* *Trans. Ill. Eng. Soc.* (*U.S.A.*), June, 11th, 1917, p. 179; *Gen. Elec. Review* (*U.S.A.*), Sept., 1917.

the right hand upper corner of the field. In this way the risk of dazzling drivers approaching on the right is minimised.

The author suggests that in general severe glare will not occur if the candle-power of the beam does not exceed 1,000; on the other hand, headlights producing 20,000—60,000 candles, which can easily be produced, are too dazzling.

An interesting device described by the writer is an appliance for testing glare. The headlight is mounted among a series of illuminated letters, and if the latter cannot be seen the light is considered glaring.

The problem is also surveyed in an article by E. J. Edwards in the *Electrical Review and Western Electrician*.* Although legislation has been introduced in many States, chiefly in the direction of limiting the power of the beam, or the length of road illuminated ahead, the results are not entirely satisfactory. While 1,000 candles is, no doubt, a satisfactory upper limit in the well-lighted streets in a city, on a country road even 100 or 200 candles may be glaring. The author illustrates this point by a diagram showing the degree of interference with vision, and the approach to the condition of totally blinding glare, with headlights of various powers. From this it appears that glare exists with relatively weak lamps below 1,000 candles, that after passing 5,000—10,000 candles we are already approaching the dazzle-limit; while from 40,000 candles onwards we are so near the limiting dazzle-point that increase in brilliancy further makes very little difference. Existing laws also prescribe limiting values for the candlepower above the horizontal. The chief considerations in the author's opinion, are to produce good illumination on the road immediately in front of the vehicle, to practically eliminate all upward light, and to limit the angle for the high intensities below the horizontal sufficiently to provide a factor of safety as regards changing loads in the machine and varying curvatures on the road surface.

An ideal system would give a good illumination on the road for up to 75 feet ahead and of a width sufficient to cover the roadway, say for 15—20 feet, while reducing light in the upward angles to the absolute practicable limit. The upper limit of the high-intensity beam should be depressed about two degrees below the horizontal. Even these conditions have disadvantages, and it is open to consideration whether alternative lighting methods should not be permissible, to be adopted, according to the judgment of the motorist, as the nature of the road suggests.

* *Electrical Review and Western Electrician*, Sept. 29th, 1917, p. 546.

Railway Signal Lights.

Some particulars of the use of electric lamps for railway signals were given by A. H. Rudd and others at a meeting of the Illuminating Engineering Society.* It was stated that on some railways lights sufficiently powerful to be seen in daylight at a distance of 500—600 feet were in use, while Mr. C. H. Morison, referring to experience on the Pennsylvania railway, said that with 37-watt lamps, giving 7,000 candles within two degrees from the centre of the beam, signals could be rendered visible at a distance of 7,000 feet in full sunlight.

Flood-lighting Projectors.

Highly concentrated filaments combined with polished parabolic reflectors have likewise been developed as searchlights and for signalling outfits. L. C. Porter† mentions a 12-candlepower lamp with a 10-inch Mangin reflector giving signals which could be read, on a clear day, as much as 50 miles away. Such

Type of lamp.	Dimensions of filament (mm.). Diam.	Length.	Max. beam candle-power.
6 volt 108 watt	2·0	6·5	462,000
32 ,, 100 ,,	5·0	5·0	223,000
110 ,, 100 ,,	6·5	6·5	142,000
110 ,, 100 ,,	8·0	8·0	32,600
110 ,, 100 ,,	25·0	0·5	12,700
110 ,, 100 ,,	30·0	68·0	3,800

units are recommended for motor-boats and coast patrols.

* *Trans. Ill. Eng. Soc.* (*U.S.A.*), Aug. 30th, 1917, p. 277.

† *Trans. Ill. Eng. Soc.* (*U.S.A.*), June 11th, 1917, p. 191.

The candlepower attainable from a searchlight is naturally largely dependent upon reducing the incandescent surface of the filament to small dimensions. To illustrate the importance of this item Porter gives the results of a series of tests on a reflector fitted with filaments of varying size, in the preceding table.

An equally important point is the correct focusing of the filament, in some cases a dispersion of the beam being deliberately produced by removing the lamp further from the focal point. In this way a range of dispersion within wide limits can be secured. This is illustrated by the illumination values obtained from a searchlight with the filament in different positions. In a case specified 22 ft.-candles was secured axially at a distance of 100 feet (equivalent to 220,000 candles). By moving the filament back $\frac{1}{4}$-inch behind the focus the maximum illumination was reduced to about one-tenth.

Some useful data on floodlighting units is provided by J. L. Stair and K. W. Mackall in two articles in the *Electric Journal*.* The 500-watt unit can be adjusted to give 10° dispersion with the filament accurately focused, but provision is made to spread the beam over 16°—18° if necessary. In the case of the 1,000-watt unit, the limit of dispersion is greater, namely, 16°—18°. The data are worked out for a 400-watt 115-volt lamp, yielding 5,920 lumens. Of the light furnished by such a unit using a 16-inch mirror with a 2·75-inch focus, 68 per cent. strikes the reflector, and of this 64 per cent. is reflected. A further 85—92 per cent. will be transmitted by an ordinary clear-glass cover. The lumens utilised in the beam are thus :—

$5920 \times 0{\cdot}68 \times 0{\cdot}64 \times 0{\cdot}92 = 2400$ lumens approximately. The efficiency of the arrangement is thus about 40 per cent.

A practical case, in which the beam is used to illuminate an inclined surface 2,300 feet distance, is worked out. The diameters of the ellipse limiting the beam where it impinges on the surface are 70 feet and 61 feet respectively. The area of the ellipse is thus approximately 3345 square feet and the illumination is $2400/3345 = 0{\cdot}7$ foot-candle approximately.

With the beam put out of focus so as to get a wider dispersion the area of the ellipse may be increased to 11,050 square feet, and the illumination will then be about 0·2 foot-candle.

In calculating the distribution of light illumination in the beam it is necessary to work from the polar curve, dividing by the square of the distance from the point concerned, on the inverse square principle, which, for moderate distances, applies sufficiently closely.

A 500-watt 115-volt lamp, in a 2·75-inch focus 16-inch diameter mirror, gives a maximum beam candlepower of about 330,000.

Special cover-lenses are also provided for particular light-distributions. For example, the glass may be provided with minute prisms to give a 40-degree dispersion, or may consist of a series of plano-concave lenses, ground vertically to spread the light in a horizontal plane only.

It is stated that when a general illumination is required near important factories and arsenals or in tunnels, &c., merely in order to facilitate supervision, the consumption necessary is only 0·01—0·02 watt per square foot of area to be lighted. A unit mounted at a height of 50 feet and throwing its maximum beam at an angle of 30 degrees below the horizontal will illuminate an area of 40 feet wide and 80 feet long. For night-construction work a higher order of illumination is naturally necessary, 0·1—0·25 watt per square foot being allowed. Cases of spectacular illumination (such as the illumination of the National Capitol and the Statue of Liberty in New York Harbour) may require special arrangements.

Apart from such spectacular displays, floodlighting is being widely used in the States for providing a protective safety-illumination round premises of importance by night. For example, a factory may mount such units at intervals on the roof so as to flood all the adjacent streets with light, and enable a watchman to detect the presence of any loitering intruder. The same practice has been applied to tunnels and subways by night and on bridges. A case is

* *Electric Journal*, Aug., 1917, pp. 296—304.

mentioned of a bridge equipped with five 200-watt units on each side, mounted eight feet above the surface of the water. The area so lighted was, roughly, 150 feet wide and 100 feet long (the breadth of the river). It enabled the guards to see at once any craft approaching the bridge whilst themselves in darkness. Such "searchlight illumination" is naturally productive of glare so far as concerns the area illuminated. A person emerging into the rays would presumably be dazzled. As, however, the illumination is specifically contrived to prevent the presence of unauthorised persons in such areas, this is not necessarily a drawback. The conditions are eminently favourable to vision on the part of the guards or observers who can see without being seen, and the presumption is that persons straying into the light are not intended to observe much. On the other hand the method would have to be used with discretion in cases where people are constantly passing on their ordinary duties, and especially where there is any amount of fast traffic.

PHOTOMETRIC TESTS OF FLOODLIGHTING PROJECTORS.

The method of testing the candlepower of floodlighting units also deserves mention. Some particulars are given by S. L. E. Rose in the *General Electric Review* (U.S.A.), and while fuller details on some points would be useful the general method of testing is explained. Experiments were made with a portable illumination photometer mounted on a tripod, the current through the lamp being adjusted with ammeter and rheostat. Tests are conveniently made at a distance of 50 to 100 feet, and in these circumstances, apparently, the inverse square law may be assumed. In a searchlight or floodlight unit all the rays in the beam come from the mirror. The application of the law in the case of automobile headlights would appear less certain, since in this case a lens is utilised, and we have, therefore, a combination of the dispersed beam from the reflector and a more or less concentrated beam from the filament operating direct through the lens. While the long distance of test usually makes it necessary to work out of doors, it is preferable to carry out the tests in a long room. This can be done if appropriate screens are used to eliminate reflections from walls and stray light. The unit to be tested may be mounted on an adjustable table and rotated while the photometer is kept still; or the unit may be kept stationary and the photometer moved across the beam. The polar curve can be conveniently plotted at intervals of one degree or less, such small intervals being desirable in view of the restricted angle of emission. Such a test readily gives the maximum candlepower and the total flux of light in lumens could also be deduced therefrom. The author mentions, however, that measurements of total flux, and comparisons of this with the corresponding flux of the bare lamp, can also be made in the Ulbricht globe—an interesting statement in view of the highly concentrated nature of the beam and the question whether the Ulbricht globe can be accurately applied in such extreme cases as this. From such measurements in the globe the efficiency of the apparatus could be readily deduced. A 2,400-watt unit yielded about 2,600 lumens in the beam—a value not far removed from that given by other observers for a similar unit,* mentioned earlier in this article. Tables are also presented giving the "lumen-constants" for successive zones and enabling the lumens in each area to be deduced.

ECONOMY IN LIGHTING IN THE UNITED STATES.

While hitherto the necessity for lighting economies has not been pressing in the United States, the problem is now beginning to attract attention. It was recently stated that the very high order of "display illumination," employed on the "Great White Way" and other main thoroughfares is to undergo some diminution.

In cases where light has been used in abundance for spectacular purposes, there is doubtless justification for economy. But the provision of proper lighting from the safety standpoint is regarded as highly important.

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* *General Electric Review* (*U.S.A.*), Sept., 1917, p. 743.

Obituary.

WILLIAM DUDDELL.

Born 1872—Died 1917.

We record with great regret the death of Mr. W. Duddell, which occurred on Sunday, November 4th. He had been in failing health throughout the past year and his sudden death, at the early age of 45 years, removes one of the most brilliant and original investigators in this country.

After serving his apprenticeship with Messrs. Davey Paxman and Co., Mr. Duddell entered the City and Guilds Central Technical College, under Professor Ayrton, in 1893. Here he remained for a number of years, being awarded several exhibitions and scholarships, and soon gave evidence of the skill in experimental work which he afterwards applied in such varied directions. Some of his earliest work dealt with the theory of the alternating current arc, and it was in the course of these experiments that he developed the oscillograph associated with his name, which has since proved such a potent instrument for the study of alternating current phenomena. His paper before the Institution of Electrical Engineers on "Rapid Variations in Current through the Direct Current Arc" was remarkable for its analysis of the musical arc as a source of high-frequency currents, which has been made use of in wireless telegraphy.

Mr. Duddell, while perhaps pre-eminent in the design of new electrical measuring instruments, made many contributions to the study of telephony, wireless telegraphy and other fields of work. His scientific interests were exceptionally wide, and his gift of lucid exposition and skill in arranging demonstrations and experiments made him an excellent lecturer. At the early age of 40 he became President of the Institution of Electrical Engineers, holding office for two successive years. He was also President of the Röntgen Society and a Vice-President of the Physical Society. He was elected a Fellow of the Royal Society in 1907 and was awarded the Hughes Medal in 1912.

Mr. Duddell acted as Honorary Secretary of the International Conference on Electrical Units and Standards held in London in 1908. He was also one of the British delegates to the International Electrotechnical Congress held in Berlin in 1913, and to the International Photometric Commission held on the same occasion, when the resolution in favour of the formation of an International Commission on Illumination was passed. Mr. Duddell became President of the National Illumination Commission in this country following the death of Mr. Edward Allen. As President of the Institution of Electrical Engineers he became *ex officio* a Vice-President and Member of Council of the Illuminating Engineering Society, and he took a keen interest in lighting matters.

After the outbreak of war he assumed important duties as a member of the Advisory Council for the Promotion of Scientific and Industrial Research, and of the Board of Inventions to the Admiralty. Recently he was created a Commander of the Order of the British Empire.

Although Mr. Duddell's exceptional gifts brought him many honours in the scientific world at an early age he retained the unassuming spirit characteristic of the true scientist and natural to his courteous and kindly disposition. The vein of light humour which he combined with his earnestness in scientific work made him a delightful companion.

TECHNICAL EDUCATION AND THE LEATHER INDUSTRY.

An address delivered by Professor Michael Sadler, Vice-Chancellor of Leeds University, to the members of the United Tanners' Federation on July 1st, contains many wise observations on technical education, which apply broadly to all industries.

Professor Sadler pointed out that the existing defects have deep roots. Technical education, in order to be effective, must be preceded by a good general education. The position of science in secondary education is still unsatisfactory. In all State-aided secondary schools science is taught, but in the public schools boys learn very little science, and their interest in the subject is blunted at the very time when it ought to be stimulated. This matter is now receiving attention from a Government Committee.

The neglect of science in secondary education is of vital importance to such industries as the leather trade, which should use their influence to secure improvement, not only in the time allotted to science, but in the methods by which the scientific spirit can be instilled and fostered.

Professor Sadler alluded to the part played by the Universities, which are in a favourable position to unite the scientific investigator and the practical worker. He urged particularly that the United Tanners' Federation should establish a research committee on which these two necessary elements should be combined; and, having done so, that they should approach the Department of Scientific and Industrial Research for their assistance and support.

Finally Professor Sadler outlined the system of education necessary for the worker entering the leather industry, the expert chemist, and for youths destined for the higher positions of responsibility. Every boy should attend day-time classes and should be regarded "not as a tool to be sharpened, but as a fellow citizen to be developed and educated." For those destined for positions of responsibility a combination of study at the University and access to works in the vacations should be encouraged.

A NEW TRIANGULATION SIGNAL LAMP.

A contribution by Mr. E. G. Fischer to *Science* refers to the special lamps required in geodetic surveys over large areas, the distance between points studied being usually from 10 to 100 miles, or even more. In the daytime use is made of the reflection of sunlight from a mirror placed accurately over the point to be indicated, while at night specially designed acetylene lamps have hitherto been used. Distances of the order mentioned can only be penetrated under favourable atmospheric conditions, and many days and nights during the season are lost owing to fog and mist. It is therefore desirable to attain a maximum brightness in the source of light used.

Experiments have recently been made by the United States Geodetic Survey on electric light. One of the chief difficulties is the supply of current from a source of small weight and bulk. Electrical generators are too heavy for transport and storage batteries are also inconvenient in this respect when great distances have to be covered. It appears, however, that the problem can be solved by using a battery of dry cells, which can be readily subdivided, and the weight distributed when making ascents. An electric lamp with a concentrated filament has been specially designed for this work. This is mounted in an automobile headlight. The apparatus also includes an ammeter, rheostat and switch. When packed in a strong case the weight is approximately 23½ lbs. It is estimated that the new arrangement will increase the number of nights during which observations can be taken by 25 per cent.

THE ORGANISATION OF ENGINEERING TRAINING.

It will be recalled that in our last issue reference was made to the forthcoming conference on Engineering Training to take place at the Institution of Civil Engineers, on October 25th, a preliminary announcement of which was made to a representative Press gathering at the Institute of Journalists on September 27th.

The meeting was opened at 3.30 p.m. by Sir Maurice Fitzmaurice, President of the Institution of Civil Engineers, a large and distinguished gathering being present.

Mr. A. P. M. Fleming read a letter from Mr. H. A. L. Fisher, Minister of Education, regretting that an important engagement prevented his being present and expressing his interest in the proceedings. The Chairman then called upon Mr. A. E. Berriman to open the discussion by a brief outline of the proposed Central Organisation for improvement in and better co-ordination of Engineering Training (information on which was also conveyed in a printed Memorandum placed in the hands of the audience).

Mr. Berriman explained that the proposal originated in an informal conference of engineers and educationists, which held several meetings at the Board of Education in the early months of 1917. The view was expressed that it would be preferable to establish the proposed organisation on an independent footing, but with the co-operation of the Board of Education and other educational bodies, and Mr. Fisher had concurred in this view. Ultimately the Council of the Institution of Civil Engineers was requested to lend their theatre for a general meeting, at which delegates representing the leading engineering institutions, educational authorities, and Government departments concerned could confer.

The three chief objects on which the proposed Central Organisation might usefully concentrate attention are summarised as follows :—

(1) The co-ordination of engineering training, including the fostering of apprenticeship as a National Institution, and the consideration of means by which the works period of an engineering pupillage may be increased in efficiency, and a wider appreciation secured for the value in industry of education of university rank.

(2) The maintenance of a Central Bureau, where parents and educationists can obtain accurate and comprehensive information relating to the engineering industry, and the proper course to pursue on behalf of boys who are desirous of making engineering their profession.

(3) The promotion of scholarships, or other equivalent means by which the best talent may be enabled to rise to the proper level under the stimulus of educational opportunity.

In the discussion that ensued a considerable number of delegates, representative both of engineering and educational aspects, took part. A general recognition was expressed that some measure of the kind suggested was necessary to place engineering education on a proper basis and enable the engineering industry of the country to maintain its pre-eminent position. On the educational side it was pointed out that this was the first opportunity provided for the public discussion of these problems between those concerned with school and university education and with the engineering industry respectively. It would be very beneficial to have a central organisation to promote constant interchange of views.

A point that was strongly emphasised by Sir John Wolfe Barry and others was the changing outlook of employers towards apprenticeship. The leading employers now recognised that, in their own interests, as well as that of apprentices, it was necessary to pay careful supervision in their training; to look to their future value, and not merely at the immediate service that youths entering engineering shops could render. In particular the wages of apprentices should be

on such a scale that it paid a boy to be properly trained; it was hopeless to expect parents to encourage their sons to undergo a long preliminary training if, on leaving school, they could earn more by undertaking immediately remunerative menial work, but without future prospects of improvement. Yet another point on which there was general agreement was the vital necessity of providing opportunities for technical education during working hours, and not at the end of the day's work when a boy was too tired to profit by classes. In this connection the Rt. Hon. Arthur Dyke Acland referred to the steps which the Government had in view for providing additional scholarships and bursaries, and suggested that the projected committee should consider how these facilities could best be utilised in connection with their reforms in education engineering training.

An important matter from the engineering standpoint, to which several speakers referred, was the allocation of expenditure on scholarships and education. Ultimately, it was suggested, the cost of education should be born mainly by the State, and it was desirable to use as fully as possible the existing facilities. Professor Dalby pointed out that the education provided at leading engineering colleges in this country was as good as that obtainable anywhere, but insufficient use was made of it. Ten years ago he had been informed that there were 10,000 students over 18 years of age taking advanced classes in engineering at Charlottenburg, where, as in England, it would be difficult to find more than 900 students of similar class. Early specialisation was not desirable. The important thing was to build up a pedestal of general engineering and scientific knowledge, on which any special studies could be based. This aspect was also touched on by Dr. Hadow, who remarked that a form of education was needed which would turn out not only good engineers but good citizens; besides vocational study, there should be opportunities for general cultivation. Sir S. Selbey Brigge (Board of Education) welcomed the scheme on behalf of his Department, and emphasised the value of representative engineering bodies with whom educationists could confer. The information bureau should prove useful, but its functions should resemble those of Appointments Boards, and it should not degenerate into an employment agency.

The following Resolution was proposed by Sir John Wolfe-Barry (Past-President of the Institution of Civil Engineers), seconded by Dr. W. H. Hadow (Principal of Armstrong College, Newcastle-on-Tyne), and supported by the Rt. Hon. Arthur Dyke Acland:—

"That this meeting of engineers and educationists is of the opinion that a need exists for improvement in and better co-ordination of engineering training, and considers that some form of central organisation is a desirable means to this end. It is therefore resolved that a representative committee, with powers to add to their numbers, be appointed to initiate means that will give effect to this principle of a central organisation, and that the first members shall be representative of the following bodies:—

Institution of Civil Engineers, Institution of Electrical Engineers, Institution of Gas Engineers, Institution of Mechanical Engineers, Institution of Mining Engineers, Institution of Mining and Metallurgy, Institute of Naval Architects, The Technical Committee of the Motor Industry, Iron and Steel Institute, Federation of British Industries, Liverpool Engineering Society, British Engineers' Association, South Wales Institute of Engineers, Institution of Civil Engineers in Ireland, Institute of Metals, Institution of County and Municipal Engineers, Junior Institution of Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, British Electrical and Allied Manufacturers' Association, Joint Committee of the Aeronautical Society and Society of British Aircraft Constructors, The Board of Education, The Headmasters' Conference, The Incorporated Association of Headmasters, The Association of Technical Institutes, The Universities and Technical Colleges of University rank.

The Resolution was carried unanimously and a vote of thanks to the Chairman concluded the proceedings.

It is announced that pending further developments communications may be sent to Mr. A. P. M. Fleming (British Westinghouse Electric and Manufacturing Co., Ltd., Trafford Park, Manchester), or Mr. A. E. Berriman (Chief Engineer, Daimler Co., Coventry), who were appointed to act as Hon. Organisers of the meeting.

SHORT NOTES ON ILLUMINATING ENGINEERING.

COLOUR SCHEMES AND SHELL SHOCK.

Much interest is being taken in the experiments of Mr. H. Kemp Prosser, the well-known artist, on the effect of colours on victims of shell shock.

These experiments are being undertaken at the McCaul Hospital in Welbeck Street. It has long been known that colours have an appreciable influence on the mind and nervous system. Red, for example, has been regarded as having a stimulating or even exciting effect, while blues and greens are sedative. It seems reasonable to suppose that in the case of men whose minds are disturbed or whose nerves are shattered these effects would be especially marked.

Accordingly the colour scheme of the wards occupied by such patients is to be carefully designed with a view to producing a harmonious but cheerful effect. The colours will be those associated with spring, and dreary autumn tints will be avoided. The walls may be yellow, the ceiling a firmament blue and the wood work green, and other appropriate tints will be given to the blinds and bed-covering. In addition, liberal use will be made of flowers of selected hues, such as delphiniums, carnations, and even mauve orchids specially imported from Salonica.

Under Mr. Prosser's supervision the production of pleasing and harmonious effects will be aimed at, and it is thought that these bright conditions will be much more beneficial to the patients than the rather drab and dreary surroundings of the average hospital ward.

THE PERILS OF UNLIGHTED STREETS

We notice in the *Gas Journal* a reference to an incident which strikingly illustrates the growing recognition of the danger of inadeqately lighted streets. At the Newton-le-Willows District Council on September 18th reference was made to a resolution passed at a meeting of the representatives of the engineering works of Earlesdown and Newton. A letter had been sent to the local police authorities saying that the men would refuse to go to work at nights unless some light was allowed in the streets owing to the many serious accidents which occurred in the excessive darkness of last winter. The Lighting Committee of the Council passed a resolution authorising the Gas Engineer to light a hundred street lamps with the tops darkened, and to let the police take proceedings if not satisfied.

THE COMBINATION OF NEON AND MERCURY TUBES FOR LIGHTING.

In a recent patent M. Georges Claude proposes the use of mercury tubes, in conjunction with neon tubes, to produce an approximately white light. A few drops of mercury are inserted into a neon tube and an alternating current is passed through until the mercury is volatilised and its greenish light completely replaces the red neon radiations. This corrector tube is then used in conjunction with an adjacent neon tube so that the addition of their radiations produces the desired white light. For this purpose the radiations must be suitably proportioned; the red and green tubes may have the same diameter and current, but the latter should be twice as long as the former.

SCHOOLROOM LIGHTING.

A correspondent sends us a note on the above subject, which appeared in *Building*, a Sydney journal. We are glad to note this evidence of interest in lighting problems in Australia. The author remarks that while many schools, states, and cities make it compulsory for the eyesight of children to be examined, relatively little effort has been made to remedy one source of such trouble—inadequate lighting of the schoolrooms. "How often," he says, "do we find beautifully designed school structures splendidly equipped, but with abominable means of illumination." There is no excuse for this condition since the advent of the professional illuminating engineer, and the many satisfactory devices and appliances now available, together with the skilled application of the same, to any problem of school lighting."

Reference is made to several main points in the lighting of classrooms, and it is recalled that tests in Philadelphia, under the direction of the Board of Education in that city, suggested that an intensity of 2·25—2·5 foot-candles, with semi-indirect lighting, gave very good results.

It is suggested that in the future school-lighting will be regulated by law, just as several states are now introducing legislation on factory lighting. In the future the services of an illuminating expert should be secured in connection with the design of school-buildings. The cost of his services will be more than saved in the reduced cost of the installation, but the protection to the pupils' eyes should be the first consideration.

POPULAR LECTURES ON HOME LIGHTING.

We understand that a popular lecture has been prepared by the Illuminating Engineering Society in the United States, entitled "How shall I Light My Home?" The lecture deals fully with general principles of domestic lighting, and the problems involved in the illumination of specific rooms, such as halls, libraries, dining rooms, bedrooms, etc., are also discussed. Descriptive lantern slides are available. Like the previous popular lecture on Store Lighting, this lecture is applicable alike to gas and electric lighting. Further particulars are obtainable from the General Offices of the Society, 29, West 39th Street, New York.

GLASS RESEARCH.

The *Proceedings of the Institute of Chemistry* (Part III.) contain some reference to the important work recently carried out on Glass Research. A quotation is made from the statement of the Minister of Munitions in the House of Commons on June 28th of the present year, acknowledging the assistance of scientific men in connection with optical apparatus required for gun sights, aeroplane photography, and many other special purposes. Previous to the war, this country could obtain from British sources only about 10 per cent. of the optical glass the country required. A whole group of industries connected with the glass trade has now been placed on a secure foundation. A process whereby great quantities of potash may be obtained has been discovered, and is being developed with the assistance of the Ministry. We should now be able to provide every ounce of potash that the glass trade requires, as well as very largely to meet the needs of agriculture.

The Glass Research Committee have added to their list, among other various and optical glasses a glass designed to hold tungsten wires sealed into it, required for the manufacture of electric incandescent lamps.

LIGHTING DIFFICULTIES IN DENMARK.

The growing need for economising coal supplies has led most of the belligerent countries to consider the matter of local lighting economies, and we note that in Germany rigid restrictions have already been made in some districts. According to the *Gas Journal*, the position in Denmark is becoming still more acute.

Denmark is specially dependent on imported supplies of coal; at a recent public meeting Mr. Rode, the Minister of the Interior, pointed out that the future was very uncertain, especially in regard to industry, gas works, and electrical supply companies in large towns.

But there was also a prospect of the shortage of other materials for illumination. It was not yet known whether supplies of petroleum could be obtained, and they had therefore endeavoured to provide lighting during the winter from train-oil spirit and calcium carbide. It was hoped that it might be possible to import carbide from carbide-producing countries. Tallow candles, train-oil lamps, and other means of lighting used in the far-distant times of the past would, perhaps, become Denmark's only method of lighting in the near future. Great privations were unavoidable, and it was only by the utmost co-operation and mutual support that Denmark would be able to fight through the fourth year of the war.

FLOODLIGHTING FOR FLOWER-BEDS.

According to the *Electrical Review and Western Electrician*, a novel use is being made of floodlights in Joplin (Mo.), where a company has applied the method to the illumination by night of the flower-beds in front of their offices. This is said to be the first time that floodlights have been used for this particular purpose, but we recall that in referring to the Franco-British Exhibition in the first volume of this journal, as far back as 1908, we advocated concealed lighting for the flower-beds in gardens and exhibitions by night.

LIABILITY FOR FAILURE TO LIGHT STREET LAMPS.

We have several times quoted cases in which the question of liability for compensation due for accidents caused by insufficient street-lighting arose. We notice, in a recent issue of the *Electrical World*, a reference to a case in South Carolina which is of interest in this connection.

In an action against a city to recover for personal injuries received in a collision caused by the defective condition of a street, where the city, which owned the electric light plant, had failed on the night of the accident to light a lamp at the crossing of two much-travelled streets, the jury might reasonably infer that city had been negligent. The Supreme Court of South Carolina held (93 S.E. 180) that the negligent failure constitutes a "defect in the street" and a "mismanagement" of the lamp, so as to render the city liable to one who suffers personal injuries in a collision between his bicycle and an automobile, caused by such neglect.

INCREASED USE OF ELECTRIC INCANDESCENT LAMPS FOR STREET LIGHTING IN THE UNITED STATES.

We understand that since the war electric incandescent lamps, especially the gas-filled variety, have been used in greatly increased numbers for street lighting in the United States. The returns for the year 1916 show an eightfold increase as compared with 1913.

RULED GLASSES FOR THE DIMINUTION OF LIGHT IN PHOTOMETRY.

In a recent article in this journal,* it was remarked that there are few satisfactory methods of dimming incident light in photometry. The use of neutral glasses is one of the most convenient devices, but in general it has two drawbacks—(1) that the glass is not exactly neutral, and (2) that it is rather difficult to obtain a progressive diminution in light by this method.

It is therefore of interest to observe that in a recent issue of the *Zeitschrift für Instrumentenkunde* Dr. H. Krüss proposes to solve this problem by the use of clear glasses on which opaque lines are ruled. This idea has been suggested by Ives in the United States, who also contrived by rotating two ruled glasses with respect to each other to vary the absorbtion progressively. If such lines are ruled closely, *e.g.*, about 100 to the inch, no appreciable shadow will be cast on the photometric field. Krüss now proposes to use two ruled screens of this kind, but to superimpose one in front of the other and alter their lateral position by means of a micrometer screw. In this way the amount of absorbtion can be progressively increased, becoming zero when the dark lines in one screen are superimposed over the clear spaces in the other. The micrometer screw-head can be calibrated in terms of the absorbtion produced.

The apparatus can be conveniently attached to a Lummer Brodhun photometer, and as the observer sees not the white screen itself but the prism surfaces illuminated thereby, he is not conscious of any inconvenient shadows in the field of view.

* *Illum. Eng.*, July, 1917, pp. 190—192.

POLARISATION FLICKER PHOTOMETERS.

Dr. S. Maisel, who is associated with the Electrotechnical Section of the Russian Technical Society, and is the Editor of *Electritchestvo*, has sent us a copy of a paper presented by him in March 1907, describing a form of polarisation photometer, similar in principle to that recently mentioned by Dr. Ives in the *Philosophical Magazine* (April, 1917), and referred to in our May issue. A description of Dr. Maisel's instrument also appeared in the Journal of the Russian Physical Society for 1907. A specimen instrument was constructed abroad previous to the war, but it is hoped that ultimately it will be made in Russia. In the final form several (either two or three) fields of view are presented, in which the flicker-phenomena are shifted in phase by 180°. Preliminary experiments have shown that this greatly increased the sensitiveness of the instrument.

Another item of news received from Dr. Maisel is that the Electrotechnical Section of the Russian Technical Society has now formed a Standing Commission on Illumination, in which members of various scientific and technical societies will take part. This is a gratifying development of illuminating engineering in Russia, which will be followed with close interest.

THE NOMENCLATURE OF RADIATION AND ILLUMINATION.

A recent paper on this subject by H. E. Ives in the *Astrophysical Journal* makes a number of detailed suggestions for the more complete description of terms used in radiation. Tables are presented showing the relation between radiation and illumination, and proposing terms to replace a number commonly used in text-books to denote the same quantity.

THE MAINTENANCE OF RESIDENCE GAS LAMPS.

In the *Transactions of the Illuminating Engineering Society* (*U.S.A.*), dated July 20th, a paper by H. H. Newman strongly advocates the undertaking of free maintenance by gas companies. There are three chief systems of maintenance in use in the United States, the "consumer request" plan, under which calls are made and lamps cared for on request; the "contract" plan, under which calls are made, lamps cleaned and worn-out parts replaced for a stipulated sum per month; and the "free maintenance" plan, under which attention is given at regular intervals free of charge, parts being renewed at regular retail prices.

In the Passaic District of the New Jersey Public Service Gas Co. the free maintenance plan has been in operation for about seventeen months, five men devoting themselves to this work. Experience shows that the average cost of labour materials and sundry expenses amounts to 0·53 dollar per lamp, while the average receipts from sales come to 0·41 dollar per lamp. The cost to the company is thus only about 0·12 dollar (approx. 6d.) per lamp during the above period, and it is felt that the service rendered was well worth this cost.

Of the 37,653 burners inspected, 46 per cent. were found to require cleaning and adjustment. It is significant that the proportion requiring attention diminished from 50 per cent. during the first 10 months, to 39 per cent. during the subsequent seven. This illustrates the advantage of free maintenance in raising the general standard of gas lighting and removing reasons for complaint. Mr. Newman remarks: "The important thing in the gas business is to sell service. Every effort should be directed toward making the service the most efficient in every way that it is possible to give."

THE MEASUREMENT OF SUNLIGHT.

A contribution by D. T. MacDougal and H. A. Spoer to *Science* points out that conventional methods of recording the intensity of sunlight do not give the same results as would a photometric measurement of physiological brightness. The pyrheliometer gives quite distinct results from photometric readings; if a physical method of measurement be adopted photo-electric action of the sodium cell in series with a suitable galvanometer probably approaches more nearly the impressions of the eye. A comparison of all such methods with records by illumination photometer is badly needed. This is a matter which deserves the attention of investigators in forestry and similar work, where it is really the action of light from the standpoint of plant life that requires to be studied.

TESTING FLASHLIGHT CELLS.

In a paper read before the American Electrochemical Society, Mr. C. F. Burgess recently discussed the problem of testing the capacity of dry-cells commonly used for flashlights and torches of various kinds. The method consisted in discharging the cell through a resistance of 4 ohms, the P.D. being taken down to 5 volts, and the discharge made intermittently for periods of eight hours a day.

It is well known that a cell will last longer if periods for recuperation are allowed, and the question of the period of discharge is therefore important. It has been shown that the results of a comparison between different types of cells vary greatly according to the period allowed. Some fail quickly if subjected to prolonged discharge and yet give more favourable results than others if only made to yield current for short intervals of time. In view of the conditions under which such cells are normally used with flashlights it was suggested that a discharge of five minutes per day might give more truer representation of a cell's capacity, although obviously this would mean that the time taken by the complete carrying out of such a test would be considerably extended.

RARE METALS FOUND WITHIN THE BRITISH EMPIRE.

On November 16th an interesting lecture was delivered at the London School of Economics by Mr. Sydney J. Johnstone on "The Rarer Key Metals."

The variety of rare minerals found within the British Empire is surprisingly large. The only important key-metal of which supplies are scanty is platinum, which is derived mainly from Russia and Columbia. Canada may, however, furnish useful supplies in the future.

Of immediate interest from the lighting standpoint is the production of tungsten, the deposits of which in Burma have the largest output in the world, while Queensland, New South Wales, also provide material quantities. Apart from its primary use for hardening steels, tungsten is largely employed for the filaments of incandescent lamps. It is satisfactory to note that, according to the lecturer, sufficient tungsten for this purpose can now be produced in the United Kingdom. Before the war there were few metallurgical firms able to smelt the tungsten ores in any quantity, but works have been established at Sheffield and Widnes and elsewhere.

Tantalum can be obtained from Western Australia, and molybdenum, vanadium and other metals used in steel alloys also occur in various parts of the Empire.

Of special interest was Mr. Johnstone's analysis of the sources of monazite sand from which the thoria and ceria required for incandescent mantles are obtained. These deposits were formerly under German control but are now available to British manufacturers. The deposits in Brazil are relatively weak in thoria, furnishing only 4—5 per cent., while the important deposits in Travancore contains twice this amount, and therefore well repay working. Other less important deposits occur in Carolina.

The deposits in Ceylon have received special attention from the Scientific and Technical Research Department of the Imperial Institute, with which Mr. Johnstone is associated. As a rule pure Ceylon monazite contains 10 per cent. of thoria, but minerals containing as much as 30 per cent. have been found. Thorianite, also found in Ceylon, which contains as much as 60—80 per cent., according to tests made at the Imperial Institute. This mineral also contains substantial amounts of uranium oxide.

Only 1—2 per cent. of ceria is required for use in incandescent mantles, but there are other useful applications. Ferro-cerium alloys are employed as pyro-phoric automatic lighters. This substance has also been employed for tracing the flight of shells, friction with the air causing the alloy to burst into flame so that the course of the shell can be traced by the luminous "tail." Cerium earth salts have also been recently applied as a constituent of electrodes in flame arc lamps.

ILLUMINATING ENGINEERING SOCIETY (U.S.A.).

New Committees on War Work.

We understand that three new Committees have been formed by the Illuminating Engineering Society in the United States (a) to deal with problems in the illumination of aviation cantonments, (b) to standardise lighting practice in industrial establishments, and (c) to carry on investigations on problems of visibility at sea. The appointment of these Committees was mentioned by Mr. C. L. Law, the General Secretary, in the report presented at the annual meeting of the Society on October 11th.

REVIEWS OF BOOKS.

ILLUMINATING ENGINEERING PRACTICE.

A series of twenty-two lectures, arranged by the Council of the Illuminating Engineering Society (U.S.A.) and delivered at the University of Pennsylvania, September 20th—28th, 1916; published in volume form by the McGraw Publishing Co. (New York), and available from the Hill Publishing Co., Ltd. (6-8, Bouverie Street, London, E.C.). [578 pp.; 5 dollars.]

(*Concluded from Vol. X, September, 1917, page 248.*)

Architectural Aspects of Lighting.

A lecture by Mr. Guy Lowell is devoted to the architectural aspects of lighting. He discusses the effects of indirect illumination, the reason for the preference expressed by some artists for lighting by candles, and the problem of the amount of light to be allotted to artistic detail: as a rule it is not desirable that *all* such decoration should be clearly seen. The lecturer also draws a broad distinction between the lighting arrangements desirable in private libraries and dining rooms, and the corresponding conditions in public libraries and restaurants.

Colour in Lighting.

The lecture on this subject by Mr. M. Luckiesh occupies thirty pages and is concluded by a useful list of references. The early part of the lecture deals with colour terminology, measurements, and mixture, on fairly familiar lines, and a short space is devoted to the physiology of vision. One of the most important practical points is the production of artificial daylight, for which a great variety of uses are mentioned. The Cleveland Museum of Art is quoted as an example of the application of artificial daylight units to the lighting of picture galleries by night. It is worth noting that when the "mellow yellow tint" of the older illuminants is desired, this can readily be obtained by a relatively slight sacrifice of efficiency, by using appropriate coloured screens with modern illuminants. Thus a gas-filled ("half-watt") lamp, normally operating at 16 lumens per watt would yield 7·4 and 11 lumens per watt respectively, when screened to simulate the colour of light from a kerosene flame, or carbon filament incandescent lamp. The efficiency in the latter case is still far above that which a carbon filament lamp would actually give.

There is also a section on coloured media, in which the properties and limitations of various dyes are discussed.

Church Lighting.

The lecture on this subject by Mr. E. G. Perrot is furnished with illustrations showing methods adopted in a great variety of churches. Many of these are of the modern type and offer full scope for the latest illuminating engineering devices. In such cases the use of central chandeliers is deprecated. Some examples of successful concealed chancel lighting are shown, and several installations are described in which indirect or cornice lighting has been effectively employed.

Lighting of Schools, Libraries and Auditoriums.

The paper on the above subject by Mr. F. A. Vaughan is also well illustrated.

The fundamental requirements in school-lighting, as stated in this lecture, are closely in accordance with those recommended in this country. The following table of illumination values deserves quotation :—

Nature of Room or Work.	Illumination (Foot-candles).	
	Minimum.	*Desirable.*
Storage, corridors, stairways, etc. ..	0·25	0·25–5·0
Rough shop work ..	1·25	1·25–2·5
Fine shop work ..	3·5	3·5 –6·0
Sewing, draughting, and the like ..	5·0	5·0 –10·0
Auditorium	2·0	2·0 –4·0
Class-rooms, study-rooms and libraries	3·0	3·0 –5·0
Gymnasium	1·0	1·0 –5·0
Blackboards ..	3·0	3·0 –5·0

Reference is made to the desirability of light-tinted mat surfaces for walls and ceilings, the avoidance of excessive contrasts, and the prevention of effects which might be considered depressing. The well-known limit of contrast of 100 : 1 is spoken of with approval ; a more detailed suggestion by Luckiesh is that the brightest object permissible visible from any normal position of the observer should not exceed 250 millilamberts (say half a candle per square inch), and the maximum permissible brightness contrast in the normal visual field should not be greater than 20 : 1. This ratio might be regarded as applying to juxtaposed surfaces. Equally important is the selection of mat surfaces for books and blackboards, and the elimination of glare caused by specular reflection.

The views of illustrations of school rooms, auditoriums and libraries are interesting as showing the diversity in methods. Semi-indirect lighting seems to meet many cases.

There are one or two specially striking examples of other methods, notably the theatre auditoriums illuminated by artificial skylights, cornices, etc. A useful combination has sometimes been made of indirect ceiling lighting, and auxiliary concealed cove lighting. Yet another interesting case is the lighting of a church lobby by indirect lighting from pedestal floor standards

In libraries it is interesting to notice several methods of dealing with the rather awkward problem of lighting shelves and racks. This is sometimes done by local shaded lamps, but one interesting method, which we imagine would only be feasible in fairly low rooms and with racks not too close together, is the use of box-units resting on the top of each rack, and throwing their light up on to the ceiling.

Factory, Office, and Private House Lighting.

These three subjects are dealt with by C. E. Clewell and N. Macbeth. Mr. Clewell summarises recent legislation affecting industrial lighting, and presents a table comparing the various "codes." Some remarks are made on the classification of work according to illumination required and a table referring to a great variety of operations is presented. From this it appears that the great majority of operations are satisfied by 3—5 foot candles, that some very fine work may require 10—15, and that many rough manufacturing processes only need about 1—3 ; while for merely unloading in yards, and for warehouse work a much lower range of values, 0·1—1·0, is permissible. Typical plans are worked out and diagrams presented showing the effect of accumulations of dust, etc., on the illumination.

In the lecture on office-lighting a comparison of the merits of direct, semi-indirect, and indirect lighting is made. Some hints on spacing and the avoidance of inconvenient contrasts in desk-lighting are given. The latter part of the lecture deals with the lighting of shops and show-windows.

The lecture by J. W. Jordan on "The Lighting of the Home" deals in succession with the various rooms in the house and indicates the lighting conditions appropriate in each case.

Street-Lighting.

This subject is subdivided into two parts, dealt with respectively by P. S. Millar and C. F. Lacombe. The former reviews the chief illuminants for street-lighting and places them on a chart connecting efficiency and consumption. The relation of the polar curve to distribution of light illumination in a street is also illustrated, but the author remarks that extreme evenness of illumination is not worth the very special arrangements necessary to secure it. Pictures are shown illustrating the difference in conditions in a street by day and by night, and the part played by reflection from the road surface in enabling objects to be seen against a bright background as silhouettes. A summary is given of a series of tests of ability

to distinguish small targets placed on the roadway; this was regarded as a criterion of the usefulness of the lighting system in enabling persons in the street to distinguish surrounding objects. An illustration is given showing the equipment for testing the candlepower of street lamps *in situ*, with an Ulbricht globe mounted on motor-trolly. Mr. Lacombe's lecture deals largely with classification of streets according to service, and the corresponding illumination to be provided.

Of the remaining papers those by G. H. Hulse and J. L. Minick deal with lighting of railway carriages and yards, etc., while Mr. W. D'A. Ryan contributes a lecture on exhibition and pageant lighting, which is illustrated by a series of beautiful coloured views of the lighting at the Panama-Pacific Exhibition.

The Journal of the Society of Glass Technology (*Vol.* 1, *Nos.* 2 *and* 3, *July and October*, 1917; *Published by the Society of Glass Technology, Secretary Dr. W. E. S. Turner, The University, Sheffield*).

In our August issue we reviewed the first number of the above journal, and we have since received Nos. 2 and 3, which cover equally interesting ground. The former contains a paper by A. M. Rowland on "The Application of Machinery and Labour-saving Devices to Glass Manufacture" and a contribution by Prof. W. G. Fearnsides on "The General Characteristics and Sources of Supply of the Refractory Materials Required by the Glass Industry."

The chief item in No. 3, in addition to shorter contributions on American high-grade sands and other matters, is the comprehensive study by J. D. Cauwood, S. English and W. E. S. Turner on chemically resistant glassware. Detailed researches on the six best varieties of glass available are described. It is very satisfactory to note that the authors regard the British glasses now being produced as not merely substitutes for but decided improvements on the previous German best. The two numbers again contain a series of short abstracts of articles in various papers dealing with glass technology, which are well worth perusal.

Renovation of the Home in War Time by Arthur Seymour Jennings (*Constable and Co., Ltd., London.* 1/- *net.*; 86 *pp.*)

In the preface to this work the author explains that it had its origin in the troubles of a lady, whose husband is at the front and who was unable to obtain the help of local painters and decorators for the annual spring-cleaning, owing to the shortage of labour. The author accordingly prepared detailed instructions as to the materials required and their method of application which were followed by the lady with highly creditable results. These notes have now been collected into a serviceable little book. The author seems to have covered the ground very fully. He gives instructions for the cleaning of wallpapers (bearing in mind the Food Controller's veto on the use of crumbled bread or flour-paste), painting walls and woodwork, and finishing wood surfaces. Information is likewise given as to the most approved stains and enamels. At the end of the work is a miscellaneous series of recipes for such purposes as cleaning bronzes, silver and ivory, and removing stains due to grease or acid. We consider that anyone who proposes to follow the example of the gifted lady mentioned in the preface would do well to have this little book by them.

"*A Fraudulent Standard*" *by Arthur Kitson* (*P. S. King and Son, Ltd., London*, 1917; *pp.* 227; 7s. 6d. *net.*)

This book contains a development of the same idea discussed in a previous volume by the same author (***Trade Fallacies***), noticed in our last issue.* Mr. Kitson restates his objections to the gold standard and discusses the possibility of agreement upon an invariable monetary unit, forming a fixed small fraction of the total national wealth. He contends, in addition, that the time is ripe for the nationalisation of the banks of the country, the suggestion being that the Government should purchase the shares in our banks by an exchange of War Loan certificates at a just valuation. In the final chapter there is an ingenious sketch of financial conditions in the "No-money islands" in which an attempt is made to show how the author's system would work out in practice.

* *Illum. Eng.*, September, 1917, p. 249.

RESEARCH ON FUEL.*

A useful Report, issued by the Committee of the Privy Council for Scientific and Industrial Research, summarises the chief lines of investigation being conducted by the Fuel Research Board, including the establishment of a Fuel Research Station. In their First Report (unpublished) the Board stated that they had in view two main lines of research: (1) a survey and classification of the coal seams in the various mining districts; (2) an investigation of practical problems entailed in the substitution for the raw coal at present burned in the grate of forms of fuel obtained from coal by carbonisation and gasification processes.

Among other points to be investigated is the question whether an economical and efficient apparatus can be devised for the carbonisation of properly selected coals at low temperature, and whether, by so doing, products of sufficient collective value can be obtained. This suggests a variety of subsidiary problems, some of which are briefly summarised in the Report. Among these are the obtaining of adequate supplies of fuel oil for the Navy by carbonisation methods, and the relation of such methods to the production of town gas and the cost of producing electric power.

But all such problems can only be solved if a thorough preliminary inquiry is made into the underlying fundamental principles.

The proposed equipment of the Fuel Research Station is fully described. It will include Retort House, Condenser and Exhauster House, Gas Holders, Gas-Producer House, Steam Boiler House, Briqueting House, Tar and Oil Stills and Condenser, Gas Furnace House, Laboratories, Offices and Workshops.

Dr. Carpenter, Chairman of the South Metropolitan Gas Co., has undertaken to give the Board valuable assistance, namely: (1) To lease to the Government at a peppercorn rent sufficient land at the East Greenwich Gas Works for the erection of the proposed Research Station; (2) to prepare drawings and specifications for this station on lines to be laid down by the Board and to make contracts for its erection; and (3) to give every facility for the transport of coal and other supplies to the station and to take over at market prices the surplus products, gas, tar, liquor and coke resulting from the operations of the Station.

A suitable site for the Station has now been agreed upon and will consist of a strip of level ground about 250 feet wide by 700—800 feet long, situated on the main siding which connects the gasworks with the South Eastern Railway and with access to an existing road.

This Research Station, as planned, will be capable of any extensions required for future researches.

* Report of the Fuel Research Board on their Scheme of Research and on the Establishment of a Fuel Research Station. (Published for the Department of Scientific and Industrial Research by His Majesty's Stationery Office, 1917. Price 2d. net.)

CONJOINT BOARD OF SCIENTIFIC SOCIETIES.

Annual Report.

We have now received a copy of the Annual Report of the Conjoint Board of Scientific Societies, containing a summary of the activities of the Board during the past year. Reference to some of these was made in a recent issue of this journal.*

We notice that among the various Committees is one designed to prevent overlapping with work. In view of the considerable number of organisations now operating in the scientific field the formation of this committee seems a judicious step.

* *Illum. Eng.*, July, 1917, p. 184.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

THE BRITISH INDUSTRIES FAIR (1918).

The Board of Trade is again organising a British Industries Fair which is to be held on Feb. 25th, 1918. Premises have been placed at their disposal by the Port of London Authority which will permit a considerably larger space being devoted to exhibits than at the corresponding Fairs in previous years. In fact the area is officially described as being "sufficient to accomodate two full-sized Rugby Football fields."

The Fair will also be conveniently situated for business men, being only a few minutes' walk from Mark Lane Station on the Metropolitan and District Railways.

Owing to the war the Fair will be again restricted to the following trades:

Earthenware and China Trade.
Glass Trade.
Fancy Goods Trade.
Paper Stationery and Printing Trades.
Toy and Games Trade.

Firms who desire to exhibit are invited to send in applications for space to the Director, British Industries Fair, 10, Basinghall Street, London, E.C.2, the final date for the receipt of applications being November 30th.

THE "BEN-GRIP" ADAPTER.

A little adapter supplied by the Benjamin Electric Limited is a device which deserves to be widely known, in view of the drawbacks attaching to adapters of a flimsy and unreliable type. It is made of non-absorbent insulating material and provided with adequate elliptical contacts to ensure good connection, and the automatic cord-grip arrangement, which obviates the necessity of threading flexible cord through holes, is also useful. A companion device is the rotating-sleeve Edison-screw adapter, which likewise contains a cord-grip and is stated to be the smallest E.-S. adapter on the market.

B.T.H. CARD CALENDARS.

We have received from the Lamp and Wiring Supplies Department of the British Thomson-Houston Co., Ltd., a pleasing little card calendar. It is in ready and convenient form on ivory card in waistcoat-pocket size for handy reference and use. Supplies, overprinted with name and address of contractors and dealers, can be obtained on application to the Publication Department, The British Thomson-Houston Co., Ltd., "Mazda House," 77, Upper Thames Street, E.C.4.

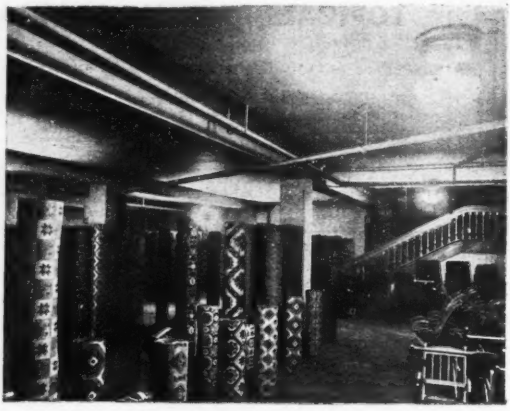
GOOD LIGHTING FOR RETAIL STORES.

In a retail store, as in a factory, the turnover is increased by good lighting, and the business of buying and selling is made less arduous. The accompanying illustration, which shows a portion of the installation (in the Linoleum Department) at Messrs. Hammond Ltd., Hull, is interesting from this standpoint.

These stores have been equipped throughout with Mazda Half-watt Lamps in conjunction with semi-indirect fittings.

The lighting is stated to be exceptionally well diffused and uniform, and is well adapted to the illumination of large vertical surfaces, such as prevail in this department.

We are informed that the whole of the lighting scheme for Messrs. Hammonds was planned and the fittings and lamps supplied by the British Thomson-Houston Co., Ltd. (Mazda House, Upper Thames Street, London, E.C.).



Lighting with Mazda Half-Watt Lamps and semi-indirect fittings of the Linoleum Department of Messrs. Hammonds, Ltd., Hull.

MINISTRY OF MUNITIONS.

Official Photographs and Samples of Women's Work.

Another exhibition of women's work took place last month at the City Art Gallery, Birmingham, illustrating the various types of work upon which women are employed in engineering and other industries on Munitions of War.

The exhibition was opened by the Lord Mayor of Birmingham on Monday, October 22nd, and terminated on November 10th.

Like the preceding exhibitions of this kind at other great industrial centres, the exhibits were successful in showing how many are the forms of skilled engineering and optical work which are now being undertaken by women's labour.

Assets exceed £2,500 000. Claims paid over £8,500,000.

By Appointment.

GENERAL

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ASSURANCE CORPORATION, Ltd.

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WAR ECONOMY.

In consequence of the War, the cost of building material and labour has increased nearly 50 per cent. All owners of property should therefore increase their Fire Insurances: this they can do at little or no extra cost by taking a Fire Bonus Policy with this Corporation, and thus effect a saving of 20 per cent. of each premium.

Particulars on receipt of post card at either of the above Offices.

F. NORIE-MILLER, J.P.
General Manager.

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£250 TWO HUNDRED AND FIFTY POUNDS will be paid by the above Corporation to the legal personal representatives of any person who is killed by an accident causing material damage to the passenger train in which the deceased was travelling as a ticket bearing or paying passenger, or who shall have been fatally injured thereby, should death result within one calendar month after such accident. **Provided** that the person so killed or injured had upon his or her person, or had left at home this coupon, with his or her usual signature, written prior to the accident, in the space provided below, which, together with the giving of notice within seven days to the above Corporation is the essence of this contract.

This Insurance only applies to persons over 14 and under 65 years of age, is subject to the conditions stated above and contained in the General Accident Fire and Life Assurance Corporation Act, 1907, and holds good for the current month of issue only.

No person can recover under more than one Coupon Ticket in respect of the same risk.

Signature .....

This Coupon must not be cut out but left intact in The Illuminating Engineer as that being dated, forms the only evidence of its currency.

LLOYD'S DIAGRAM FOR CALCULATIONS.

The above name is attached to a chart to facilitate calculations, issued by Messrs. E. and F. N. Spon, Ltd. The chart carries two identical horizontal numbered scales at top and bottom, and similar duplicate vertical scales on the left and right. The latter numbers are connected by horizontal cross lines, while the former are linked by both vertical lines and sloping lines shaded red. The intervals between successive numbers are so proportioned that inspection of the chart enables the result of multiplying any number in the horizontal scale by another number in the vertical scale to be readily determined. There are also additional sloping lines to enable squares and cubes or square and cube roots to be ascertained.

The chart thus fulfils functions similar to those of a slide rule. While it is naturally necessary to become familiar with its working in order to use the chart with ease and convenience, the device should be helpful to engineers and others wishing to get rapid and approximate results. The price is 2s. 6d.

THE APPLICATION OF GAS TO WAR INDUSTRIES.

A recent issue of *A Thousand and One Uses for Gas* illustrates some interesting processes in munition factories in which gas-heating plays an essential part. Among these are included annealing tool-steel bars in oven furnaces, case-hardening of component parts of rifles, furnaces for annealing wire, the re-heating of motor-cycle parts, &c. Other illustrations show the application of gas in non-ferrous processes, *e.g.*, for the melting of brass, copper, and aluminium.

Some very striking figures are given for the increased gas consumption in various industrial towns; in some cases the amount of gas used in 1916 exceeds by over 100 per cent. that employed in 1913. Similar data are given for nine typical war factories, where, in one case, an increase of 3,314 per cent. is actually recorded.

THORIUM FROM THE UNITED STATES.

It is well known that one of the greatest difficulties experienced by the incandescent mantle industry upon the outbreak of war was the cutting off of the thorium and cerium supplies which had been obtained from the German monopoly.

Special interest therefore attaches to the efforts of the Lindsay Light Co., of Chicago, who stepped into the breach by immediately putting down a new plant for the preparation of these materials. We observe that this plant now requires the attention of over 80 men, with 12 vats working 144 hours a week and using 2½ tons of monazite sand a day. According to the *Gas Record*, the total thorium output for the year is sufficient for nearly 150,000,000 mantles. The product is guaranteed to contain 48 per cent. oxide and is manufactured with scrupulous care. Messrs. Paul Winn & Co., Ltd. (72, Mark Lane, E.C.), are the sole agents for Europe.

BARIMAR THERMIT WELDING.

We understand that the Board of Trade have now given formal sanction to a new company, with works in London and Liverpool, and known as the British Barimar-Thermite Welding Co., Ltd., to take up and exploit the thermit welding process which, prior to the war, was exclusively in German hands.

Thermit is stated to be specially applicable to tramway welding and for the repair of heavy castings and machine parts, and it is the intention of Mr. F. W. Brett, the Managing Director and General Manager of Barimar, Ltd. (who is largely responsible for the formation and management of the new company), to train disabled British soldiers and sailors to carry on the work. The registered offices of the new company are at Poland Street, London, W.1.

The Illuminating Engineering Society.

(FOUNDED IN LONDON, 1909.)

NOTICE OF NEXT MEETING.

The next Meeting of the Ninth Session of the Society will take place at the House of the Royal Society of Arts (18, John Street, Adelphi, London), at **5 p.m.**, on **Tuesday, January 15th,** when a Paper on ***"Ten Years of Illuminating Engineering: Its Lessons and Future Prospects,"*** will be read by Mr. L. GASTER.